Systematic Review


Tadakazu Miyao¹, Shigeo Osato¹,*, Irika Miyao¹, Yukari Nakajima¹, Masayori Shirakawa²

¹ Dento-Oral Science Institute, Chiyoda-ku, Tokyo, 102-0072 Japan
² School of Dentistry, Meikai University, Saitama, 350-0283 Japan

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Abstract – Purpose: This study aimed to evaluate differences in 10 items of treatment details in patient regarding cases between 2015–2017 (EP) and 2018–2020 (LP) from scoping literature review of displaced dental implant (DDI) retrievals. Materials and methods: PubMed, Google Scholar, and ScienceDirect were searched using key words including "displaced," "retrieved," "migrated," or "accidental" dental implants. Treatment details were analyzed for the differences between EP and LP in 92 cases from 32 articles published in 13 countries. Statistical significance was evaluated using the Mann-Whitney U-test, Fisher's exact test, and Pearson's correlation analysis. Results: In the comparison between EP and LP, there was no significant difference in the number of publication countries (11 vs. 10), number of published articles (17 vs. 15), distributions of cases (50 vs. 42), mean age of patients (55.9 ± 1.8 years vs. 55.3 ± 2.5 years), male-female distribution (31/19 vs. 24/18), and distribution of displacement into the maxillary sinus and other regions (46/4 vs. 34/8), and no significant difference in the Pearson's correlation between publication years and the number of articles. DDI retrievals utilized intraoral and endoscopic surgeries (61.2% and 82.5%), transoral and transnasal approaches (93.8% and 81.8%), and local and general anesthesia (64.7% and 76.3%) during EP and LP, respectively. Moreover, significant differences were observed in all distributions between the two factors (30/19 vs. 7/33 cases, 30/2 vs. 6/27 cases and 2/12 vs. 9/29 cases) in EP and LP, respectively (P < 0.01). Conclusions: These results suggest that most DDI retrievals in otorhinolaryngology since 2018 have been mostly performed using transnasal endoscopic approaches under general anesthesia.

Introduction

Dental implant treatment is widespread worldwide and improves the quality of life (QOL) by enhancing esthetics and restoring the oral function of individuals who have lost their teeth [1,2]. From being just a popular option, dental implants are now considered the global standard for prosthetic rehabilitation of patients with missing teeth [3–10]. On the other hand, most cases of periodontitis are treated by dental implants, and there is increasing use of implants due to the “implant mind”; therefore, the prevalence of peri-implant lesions and diseases is increasing year by year. In recent years, inappropriate approaches and abuse have become a problem in dental implant treatment [11].

The practice of dental implant treatment varies from anatomically and surgically easy to difficult [12,13]. Bone augmentation by socket or sinus lift procedures is often necessary to accommodate dental implants in the maxillary posterior region because of the limited height of available bone. In addition, achieving primary stability of the placed dental implant is difficult when the bone quality of the residual alveolar bone is poor, increasing the risk of dental implant displacement. Therefore, advanced strategies and surgical skills the dental practitioner are of paramount importance [14–19]. Bone augmentation may also be required for dental implant treatment in the posterior mandible with severe alveolar bone resorption [5,20]. This procedure is performed by dental practitioners who have varied experience in dental implant surgery and techniques [16,21,22], suggesting the occurrence of potential complications associated with dental implant surgery. One of the complications, for example, is the displacement or migration of dental implants from their original to ectopic sites [16,23]. Displacement or migration of dental implants occurs primarily during the perioperative period of dental implant surgery, though it can even occur after the placement of dental implant prosthesis [9,16,23–29]. Displaced
dental implants (DDIs) have been reported to migrate to the paranasal sinuses [10,22,26,30,31], mandibular body [24,32] and canal [33], submandibular space [5], buccal space [34], and even to distant locations, such as the esophagus [35] and stomach [36].

Patients with DDIs not only exhibit localized pain, swelling, discomfort, and/or complications after the surgery, but are also referred to university hospitals on physical and psychological distress [7,10,27,30,37]. Such patients should undergo dental implant removal surgery as soon as possible to prevent further complication [4,5,10,16,19,25,36,38].

Previous reports have mainly discussed the anatomical sites of DDIs and surgical procedures and clinical outcomes of DDI retrieval cases. Based on the reports and reviews of DDI cases, we believe that quantitative evaluation of previously unclear parameters, such as the country of publication, changes in the number of published articles by year, patient background, and treatment details is important. Hence, we decided to conduct comprehensive research on literature published in time frames of limited duration.

The purpose of this study is to evaluate the differences in 10 items regarding DDI cases (the number of publication countries, number of articles, changes in the number of articles, number of cases, age and sex of patients, displaced anatomical sites, treatment techniques, surgical approaches, and anesthesia types) in articles published between 2015–2017 and 2018–2020; and to also analyze the correlation between publication year and number of articles published between 2015 and 2020.

Materials and methods

This meta-analysis has been reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Fig. 1) (http://www.prisma-statement.org/PRISMAStatement/FlowDiagram).

Sources

Four investigators searched the electronic databases of PubMed/MEDLINE, Google Scholar, and ScienceDirect comprehensively for articles pertaining to DDIs published between January 2015 and December 2020. The databases were searched for the following keywords: (“displaced” OR “migrated” OR “accidental” OR “retrieved”) AND “dental implants”

Literature selection and data collection

From the results of this search, four investigators (T.M., S.O., I.M. and Y.N.) excluded literature that did not mention the age and sex of the patients (Tab. I). On the other hand, the evaluation of the periodontal index for the periodontal disease of patients was not included in the selection criteria. Subsequently, only treatment details identified in this study, from available records of each patient, were statistically analyzed. All the selected articles were published in English and comprised case reports, original studies, and systematic reviews. After manually going through the bibliography of the cited articles, all duplicates were removed.

The following 10 items pertaining to the treatment details of patients, shown in Table II, were evaluated: the number of publication countries (a), number of articles (b), changes in the number of articles by year and the correlation between publication year and number of articles published in that year (c), number of cases (d), age (e) and sex (f) of patients, anatomical sites of DDIs (g), treatment techniques (h), surgical approaches (i), and anesthesia types (j). Thereafter, only the definite information provided in the articles pertaining to these items was entered in an Excel spreadsheet (Microsoft Corporation, Redmond, Washington, US), and the total number (n) was calculated as the sample size for each item.

The six years assessed in this study were divided into two periods: 2015–2017 (early phase: EP) and 2018–2020 (late phase: LP). As shown in Table II, two attributes for items (f to j) were provided: sex as male and female, displaced anatomical sites as maxillary sinus (MS) and other regions (OTH), treatment techniques as intraoral surgery (IS) and endoscopic surgery (ES), surgical approaches as transoral approach (TOA) and transnasal approach (TNA), and anesthesia types as local anesthesia (LA) and general anesthesia (GA).

Statistical analysis

The differences between the EP and LP were statistically analyzed for the following nine items. The mean age of patients (item e) was compared using the Mann-Whitney U-test. The frequency distribution for items a, b, and d were compared using exact binomial tests. Furthermore, that for items f, g, h, i and j was compared using the Fisher’s exact test. For analyzing the association between the publication year and number of articles (item c), the simple correlation coefficient (r) was calculated, and statistical significance was determined using Pearson’s correlation test. A P-value of less than 0.05 was considered to be statistically significant. The software used for statistics was js-STAR version 9.8.7j (Satoshi Tanaka & Nappa [Hiroyuki Nakano], Tokyo, Japan). This software is freely available at www.kisnet.or.jp/nappa/software/star/.

Results

The literature search resulted in 38 articles published across 14 countries with 309 cases (329 implants). In our meta-analysis, we excluded literature that did not describe the age and sex of the patient and finally selected 32 articles published across 13 countries with 92 cases (100 implants) (Tab. I and Fig. 1). The details of dental implant treatment pertaining to the 10 items included in the articles that met the inclusion criteria are shown in Table I, and the results of statistical analysis are shown in Table II and Figures 2 and 3.
Figure 2 shows the number of countries in which the articles were published and the number of articles on DDI cases published in those countries during the study period. The maximum number of articles was published in Korea (4 and 3 articles) and Italy (3 and 2 articles) in the EP and LP, respectively. In Brazil, one more article was published in the LP than in the EP. In other countries, the number was slightly less or the same in the LP than in the EP.

The number of publication countries (11 [52.4%] vs. 10 [47.6%]; \(P = 1.0000\)) and the number of articles (17 [53.1%] vs. 15 [46.9%]; \(P = 0.8601\)) in the EP and LP were lower in the LP than in the EP, but the differences were not significant (Tabs. IIa. and IIb).

### Number of articles by year

Figure 3 shows the changes in the number of articles published from 2015 to 2020, by year. The maximum number of published articles in a year was 8 in 2016 and the minimum
Table I. Detailed treatment record of displaced dental implant cases in 32 articles published from 2015 to 2020.

<table>
<thead>
<tr>
<th>No.</th>
<th>Authors</th>
<th>Publication year</th>
<th>Country</th>
<th>Case</th>
<th>Age (years)</th>
<th>Sex</th>
<th>Implant Anatomical sites</th>
<th>Treatment techniques</th>
<th>Surgical approaches</th>
<th>Anesthesia types</th>
<th>Hospital departments</th>
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<td>2015</td>
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<td>60</td>
<td>Male</td>
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<td>ES</td>
<td>TOA</td>
<td>GA</td>
<td>OMS</td>
</tr>
<tr>
<td>2</td>
<td>Bruniera et al. [4]</td>
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<td>Brazil</td>
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<td>TOA</td>
<td>LA</td>
<td>OMS</td>
</tr>
<tr>
<td>3</td>
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<td>65</td>
<td>Female</td>
<td>1 MS</td>
<td>IS</td>
<td>TOA</td>
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<td>OMS</td>
</tr>
<tr>
<td>4</td>
<td>Sadda [39]</td>
<td>2015</td>
<td>US</td>
<td>1</td>
<td>55</td>
<td>Male</td>
<td>1 MS</td>
<td>IS</td>
<td>TOA</td>
<td>LA</td>
<td>OMS</td>
</tr>
<tr>
<td>5</td>
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<td>Italy</td>
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<td>49</td>
<td>Female</td>
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<td>ES</td>
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<td>ORL *</td>
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<tr>
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<td>India</td>
<td>1</td>
<td>54</td>
<td>Male</td>
<td>1 Buccal soft tissue</td>
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<td>NC</td>
<td>LA</td>
<td>OMS</td>
</tr>
<tr>
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<td>2016</td>
<td>Spain</td>
<td>1</td>
<td>66</td>
<td>Male</td>
<td>1 Sublingual space</td>
<td>IS</td>
<td>NC</td>
<td>GA</td>
<td>OMS</td>
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<tr>
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<td>Israel</td>
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<td>Male  (12)</td>
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<td>ES (11) and NA (1)</td>
<td>TOA (10)</td>
<td>GA (8) and LA (13)</td>
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<td>Italy</td>
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<td>TNA</td>
<td>GA</td>
<td>ORL *</td>
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<td>ES</td>
<td>TOA</td>
<td>NC</td>
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<td>TNA</td>
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<td>LA</td>
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<td>GA</td>
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<td>TNA</td>
<td>GA</td>
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<td>TNA</td>
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<td>LA</td>
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<td>ES (2)</td>
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<td>1 MS</td>
<td>ES</td>
<td>TNA</td>
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Table I. (continued).

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<th>Country</th>
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<th>Sex</th>
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<td>92</td>
<td>89</td>
<td>65</td>
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Abbreviations: ES, endoscopic surgery; GA, general anesthesia including intravenous sedation; IS, intraoral surgery; LA, local anesthesia; MS, maxillary sinus; NA, not available; NC, not clear; OMS, oral and maxillofacial surgery; ORL, otolaryngology, and including a case of collaboration between oral and maxillofacial surgeon and otorhinolaryngologist (ORL*); TNA, transnasal approach; TOA, transoral approach; US, The United States of America; (Parentheses), number of patients and cases. US, The United States of America; TNA, transnasal approach; TOA, transoral approach. * Author’s numbers.
† Spontaneously excretion.
‡ Mean age of 14 patients: 54 ± 9.4 years.
§ Range 35–72 years (each age of 21 patients: 58, 50, 56, 62, 55, 45, 65, 47, 47, 59, 35, 63, 67, 59, 72, 70, 39, 59, 49, 36, and 64 years). This age was excluded from the statistical data due to median age 62 years of 24 patients (range 35-88 years).
was 3 in 2018. The Pearson’s correlation coefficient for the correlation between changes according to year and number of articles was low ($r = 0.06$), and no statistical significance was observed ($P = 0.9157$) (Tab. IIc).

### Number of cases

The number of DDI cases was fewer by 8 (8.6%) in the LP (42 cases [45.7%]) than in the EP (50 cases [54.3%]), but the difference in the distributions was not statistically significant ($P = 0.4657$) (Tab. IId).

### Age and sex of patients

The mean age of male and female patients was 0.6 years lower in the LP (mean ± standard error [SE], 55.3 ± 2.5 years [95% confidence interval (CI), 50.4–60.1 years]; range, 32–73) than in the EP (mean ± SE, 55.9 ± 1.8 years [95% CI, 52.4–59.3 years]; range, 35–71), but the difference was not statistically significant ($P = 0.7212$). In sex distribution, the number of males (31/50 [62.0%] and 24/42 [57.1%]) was greater than that of females (19/50 [38.0%] and 18/42 [42.9%]) in both the EP and LP. Moreover, male-female distributions (31/19 vs. 24/18) between the EP and LP showed no statistically significant differences ($P = 0.6739$) (Tab. IIe and f).

### Anatomical sites of the DDIs

The DDIs were mostly reported in the MSs in both the EP and LP, with 46 cases (46/50 [92.0%]) and 34 cases (34/42 [81.0%]) reported in the MSs, respectively. Evidently, fewer cases of dental implant displacement were reported in OTH (including ethmoid sinus, pterygoid fossa, orbit, the mandibular body and canal, esophagus, and other sites) as shown in Table I. Further, the difference in the distribution of cases in the MS and OTH (46/4 vs. 34/8 cases) between the EP and LP was not significant ($P = 0.1336$) (Tab. IIg).

### Treatment techniques and surgical approaches

The treatment techniques for dental implant placement and surgical approaches used for retrieval of the DDI differed significantly between the EP and LP. IS was mostly used in the EP (30 cases: 30/49 [61.2%]), whereas ES was mostly used in the LP (33 cases: 33/40 [82.5%]). Additionally, TOA was mostly performed in the EP (30 cases: 30/32 [93.8%]), whereas TNA was mostly performed in the LP (27 cases: 27/33 [81.8%]). The differences in the distributions of cases between the EP and LP in IS and ES (30/19 vs. 7/33 cases) and in TOA and TNA (30/2 vs. 6/27 cases) were significant, respectively (both $P = 0.0000$) (Tab. IIh and i).

### Anesthesia types

The DDIs were mostly retrieved under LA in the EP (22 cases: 22/34 [64.7%]) and GA in the LP (29 cases: 29/38 [76.3%]), and the difference in distributions of cases between EP and LP in LA and GA (22/12 vs. 9/29) was statistically significant ($P = 0.0007$) (Tab. IIj).

### Discussion

As a result of comparing 10 items regarding DDI cases between the first half of EP (2015–2017) and the second half of LP (2018–2020), significant differences were found in treatment techniques, surgical approaches, and anesthesia types.

In daily clinical practice, with the rapid increase in implant-based reconstruction, the opportunities of encountering complications (mainly infection, postoperative pain, intraoral...
hemorrhage, penetration or displacement or dislocation into the maxillary sinus, and neurosensory disturbances) have increased. Dental implant displacement can occur perioperatively, postoperatively, and several years later. In the 32 articles we investigated, 51.1% (47/92 cases) were found perioperatively and 32.6% (30/92 cases) after superstructure placement, and the results were supported by the previous reports [9,16, 23-29].

Jeong et al. (2016) [49] reported 22 articles (49 implants) being published in 14 years from 2000 to 2013. In our study period of six years from 2015 to 2020, we found 32 articles and 92 cases (100 implants) in 13 countries. This number is prominently greater than that reported previously. Sgaramella et al. (2016) [22] encountered 21 cases in the last 20 years (1990–2010). Gnigou et al. (2019) [16] examined the literature reviewed by Sgaramella et al. (2016) [22] and found that 14 cases were reported between 2000 and 2010, which were twice as many as had been reported the previous decade (1990–1999). However, they concluded that the accurate incidence of these cases is unknown because of asymptomatic cases and inadequate cohort studies.

No previous article has reported the number of countries where articles pertaining to DDI have been published. In our study duration of six years, the number of articles published was similar between the EP (11 countries) and LP (10 countries), and the number of presentations was 17 articles and 15 articles, respectively, with no significant increase or decrease. The maximum number of articles was published in the Republic of Korea (4 and 3 articles) and Italy (3 and 2 articles) in the EP and LP. In Brazil, the number was more in the LP (2 articles) than in the EP (1 article). However, in other countries, the number was either less or equivalent. Hence, it is necessary to perform additional studies with greater number of cases in the future.

The changes in the number of articles on DDI retrieval, by year, are not well known. The results of this study show that 3 to 8 articles were reported each year between 2015 and 2020, the Pearson’s correlation coefficient (r = 0.06) between the year and the number of articles was low, and no significant association was found. In other words, dental implant practitioners must be aware of the current situation wherein complications pertaining to DDI may occur. Though the number of these cases is less, these aspects must be considered to prevent complications [22,50].

Table 2. Comparison of the mean age and frequency distributions between early phase (EP) and late phase (LP) regarding 10 items (a–j) for displaced dental implant articles.

<table>
<thead>
<tr>
<th>Research items</th>
<th>Factor</th>
<th>Early-phase</th>
<th>Late-phase</th>
<th>Total</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>a Country</td>
<td>11</td>
<td>10</td>
<td>21</td>
<td>1.0000†</td>
<td></td>
</tr>
<tr>
<td>b Article</td>
<td>17</td>
<td>15</td>
<td>32</td>
<td>0.8601†</td>
<td></td>
</tr>
<tr>
<td>c Articles by year</td>
<td>Correlation</td>
<td>Refer Fig. 2</td>
<td>Pearson's r = 0.06</td>
<td>0.9157†</td>
<td></td>
</tr>
<tr>
<td>d Case</td>
<td>Males and females</td>
<td>50</td>
<td>42</td>
<td>92</td>
<td>0.4657†</td>
</tr>
<tr>
<td>e Age</td>
<td>Mean ± SE</td>
<td>55.9 ± 1.8</td>
<td>55.3 ± 2.5</td>
<td>53</td>
<td>0.7212†l</td>
</tr>
<tr>
<td>f Sex</td>
<td>Male</td>
<td>31</td>
<td>24</td>
<td>55</td>
<td>0.6739q</td>
</tr>
<tr>
<td>g Anatomical sites</td>
<td>MS</td>
<td>46</td>
<td>34</td>
<td>80</td>
<td>0.1336q</td>
</tr>
<tr>
<td>h Treatment techniques</td>
<td>IS</td>
<td>30</td>
<td>7</td>
<td>37</td>
<td>0.0000q</td>
</tr>
<tr>
<td>i Surgical approaches</td>
<td>TOA</td>
<td>30</td>
<td>6</td>
<td>36</td>
<td>0.0000q</td>
</tr>
<tr>
<td>j Anesthesia types</td>
<td>LA</td>
<td>22</td>
<td>9</td>
<td>31</td>
<td>0.0007q</td>
</tr>
<tr>
<td></td>
<td>GA</td>
<td>12</td>
<td>29</td>
<td>41</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: ES, endoscopic surgery; IS: intraoral surgery; GA: general anesthesia; LA, local anesthesia; MS, maxillary sinus; n, number of patients; OTH, other regions; SE, standard error; TNA: transnasal approach; TOA, transoral approach.

* Duplicate country names were counted as one.
† Exact binomial tests.
‡ Pearson’s correlation coefficient (r) between publication year and the number of articles
§ Pearson’s correlation test.
‖ Mann–Whitney U-test.
¶ Fisher’s exact test.
A P-value of less than 0.05 was considered to be statistically significant.
Moreover, previous studies have not compared the number of DDI retrieval cases during two limited periods. In this study, the number of DDI search cases decreased by 8.6% in LP (42 cases [45.7%]) compared to EP (50 cases [54.3%]). One of the reasons for this decrease is that 3D image diagnosis using cone-beam computed tomography (CBCT) imaging is possible, which is considered to be useful for risk aversion [19].

Regarding the average ages of male and female patients with DDI, Chiapas et al. (2009) [28] and Sgaramella et al. (2016) [22] reported 55 and 53.9 years, respectively, and they were close to the results of EP (55.9 years) and LP (55.3 years). It was also found that there was no significant difference between patient ages and between the results of EP and LP. Currently, the dental implant treatments have been provided not only to older patients with partially and completely edentulous jaws but also to young adults who have lost one or a few teeth. Some younger patients do have DDIs, and this decreases the mean age.

Pistilli et al. (2018) [24] reported that most patients were female. However, our results showed that males were more frequently affected in both the EP and LP (62.0% and 57.1%, respectively) than females, but there was no significant difference in sex distribution, a finding in contrast to their study.

Conventionally, the most frequently reported anatomical site of DDIs is MS [50]. Similarly, in our investigation, both the EP (92.0%) and LP (81.0%) reported same numbers of DDIs in the MS, and no significant difference was observed between the two phases. The factors contributing to DDIs include poor diagnosis, inadequate treatment planning, inadequate experience in surgical procedures, and improper use of surgical instruments [8,26,42]. In addition, loss of maxillary molar increases the pneumatization of MS, leading to insufficient residual bone volume and poor bone quality [3,9,52-54]. Dental implants in the posterior maxilla often show movement, and obtaining initial stability is difficult, which leads to a possibility that these dental implants will eventually perforate or migrate into the MS. Occlusal overload may also lead to dental implant displacements. Dental practitioners should accurately assess the sinus morphology and the anatomical structure and variations of the surrounding bone using CBCT while planning dental implant therapy in the posterior maxilla [37,42,49,55].

Regarding the retrieval technique of DDIs, Chang et al. (2020) [25] reported four surgical removal techniques. According to our study, IS was used in 61.2% patients in the EP, whereas ES was used in 82.5% patients in the LP, with the differences being statistically significant. So far, the Caldwell–Luc technique or lateral window technique [29] has been reported to cause greater surgical invasion and the occurrence of a postoperative cyst [23,27,49,56,57]. However, ES is less surgically invasive and less likely to cause postoperative cysts [27,58].

Furthermore, when the DDI migrates to or near the inferior or anterior wall of the MS, the prelacrimal recess approach could be used for DDI retrieval, as it provides a panoramic view [27,35,59]. Therefore, the incidence of postoperative facial numbness was lower than that with the Caldwell-Luc technique. Otorhinolaryngologists use the fenestrated approach in the MS or modified transnasal ES by creating a small hole in the inferior nasal meatus [25,60]. Oral and maxillofacial surgeons and otorhinolaryngologists should select safe and minimally invasive surgical procedures for the retrieval of DDIs [7,10,43,44,49].

Dental implants displaced intraoperatively are removed by creating a fenestration in the sinus floor through the alveolar socket and extracting the dental implant using a Klemmer plier or maxillary elevators [38,45] or aspirated using a suction device. We often use the cuffed forceps with a long handle. If a dental implant is displaced days or months after surgery, it can be removed by TOA or TNA according to the patient symptoms [38,45,61].

According to our analytical findings, TOA (93.8%) was mostly used in the EP, whereas TNA (81.8%) was used in the LP, which shows that the treatment technique had changed significantly. Since 2018 (LP), most patients have been referred to the department of otorhinolaryngology at university and specialty hospitals and have undergone surgical removal of DDI (32/42 cases; 76.2%; Tab. 1) [25,29]. Close cooperation between oral and maxillofacial surgeons and otorhinolaryngologists is essential for early and proper patient treatment and to prevent complications [19,23,25,26,38].

Conventionally, LA has been frequently used for the removal of DDIs. We found that LA (64.7%) was mostly used in the EP, and GA (76.3%) was mostly used in the LP. This could be because of the priority given to the safety of the patient during removal surgery, control of patient movement during the surgery, prevention of ectopic migration during inspiration, and the ability to quickly treat discomfort and complications associated with the dental implant placement surgery [22,26,35,36,45,62].

To summarize our findings, over the past 6 years, 32 articles and 92 cases of DDIs have been reported in 13 countries worldwide; of these cases, dislocations or migrations in the MS were predominant. The treatment techniques, surgical approaches, and anesthesia types had changed significantly between 2018–2020 (LP) and 2015–2017 (EP). DDIs are now removed by transnasal approaches under GA in the department of orotracheal surgery at medical universities and specialty hospitals.

Therefore, to avoid complications, dental practitioners should precisely evaluate the three-dimensional anatomical structure and its variations on CBCT imaging and perform three-dimensional simulations before performing the actual dental implant surgery, and also immediately refer to an experienced specialist if any unanticipated problems occur.

**Conclusion**

Comparing 2015–2017 (EP) and 2018–2020 (LP), no significant differences were found in the patient’s seven background factors (items a–g) regarding DDIs. However, most surgical retrievals in the LP were mostly performed in
otorhinolaryngology departments using a transnasal endoscopic approach under GA compared to those in EP (items h–j) since 2018. Therefore, dental practitioners should discuss with their patients that if there is a risk prior to dental implant surgery, they may be referred to an experienced specialist. Results of this analysis need to be validated by using many search engines and comparing them with well-designed studies on this subject with a larger number of cases.

Authors’ contributions

T. Miyao: Concept / design, data collection, data analysis / interpretation, drafting article, and approval of article. S. Osato: Concept / design, data collection, statistics, data analysis / interpretation, critical revision of article, responsible for the data analyses, and approval of article. I. Miyao: Data collection, drafting article, and approval of article. Y. Nakajima: Data collection, drafting article, and approval of article. M. Shirakawa: Data analysis / interpretation, critical revision of article, and approval of article.

Conflict of interest

The authors declare that they have no conflicts of interest in relation to this article.

Informed Consent

The authors declare that informed consent not required.

Ethical committee approval

The authors declare that Ethical approval not required.

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